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 GB 2200928 A WO 82/01019 A1 US 4338158 A

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 SELECTED PUBLICATIONS

(54) Method of and apparatus for producing cellulosic paper pulp

(57) A process of manufacturing cellulose paper pulp from bagasse, jute, straw and like raw materials of relatively low lignin content comprises passing the raw material upwardly along a digester (1) down which hot alkaline liquor passes in a counter flow, feeding the treated material to a screw press (10), mixing it with aqueous magnesium salt and fluffing it in a shredder (11) and then passing the material down through a vertical oxygen reactor where it is treated with hot oxygen whereafter it is mixed with hot water to obtain a suspension, gases are removed from the suspension and the latter is pressed to dryness of 20 to 35%.

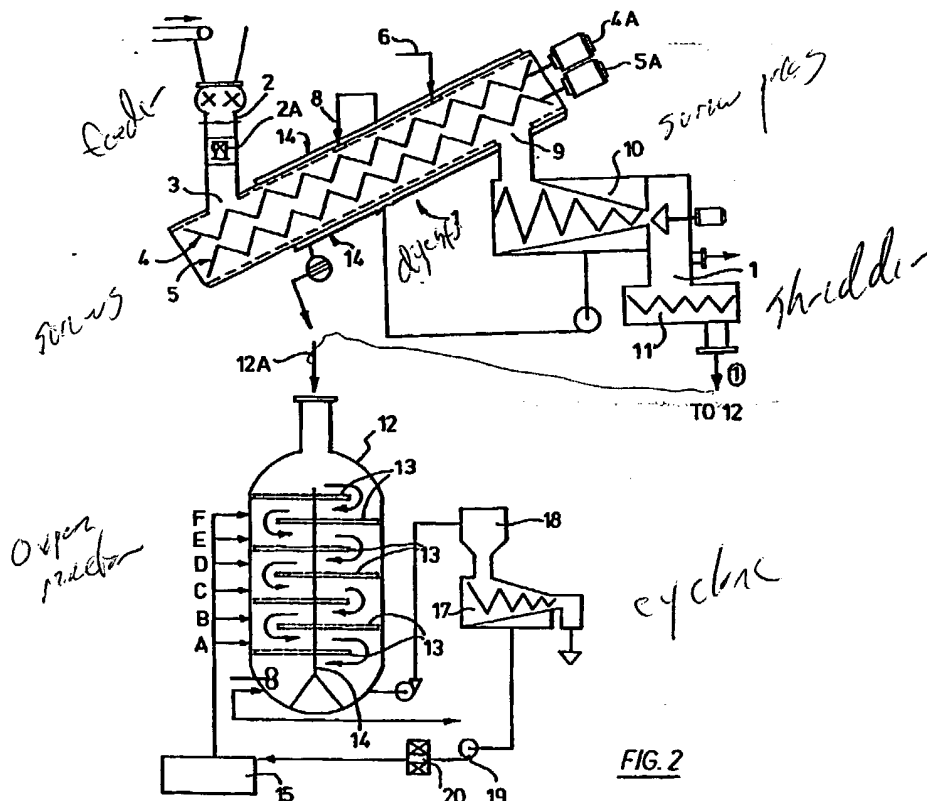
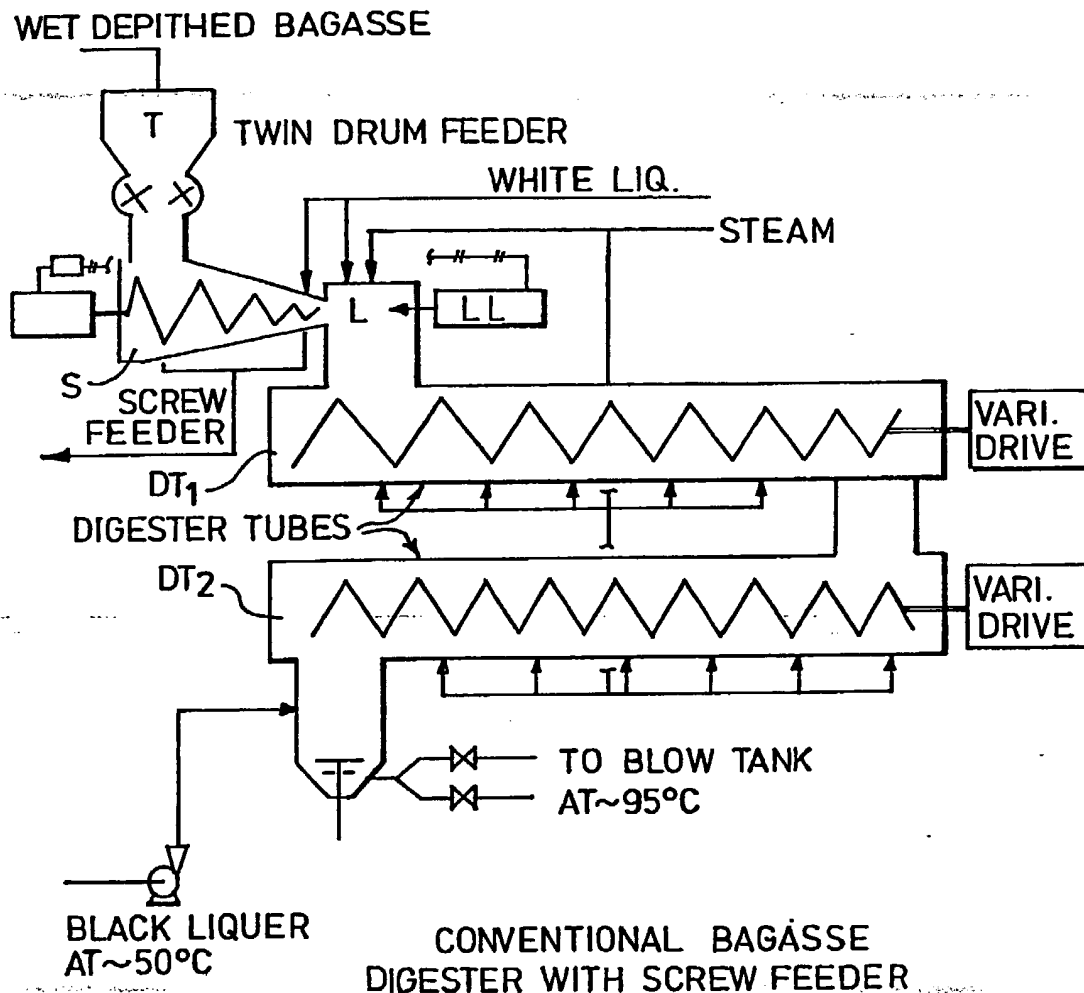


FIG. 2

GB 2 265 918 A

FIG.1

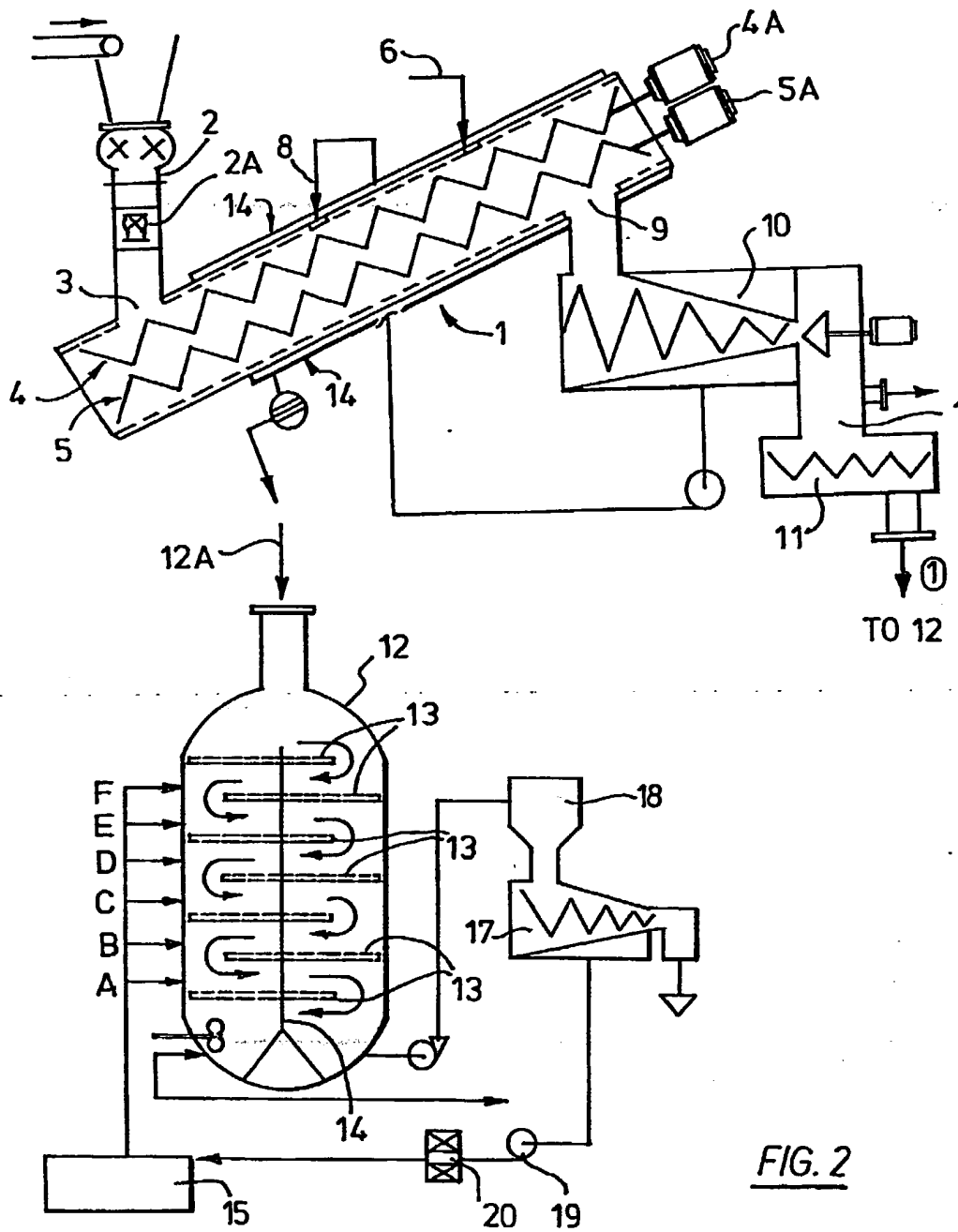


FIG. 2

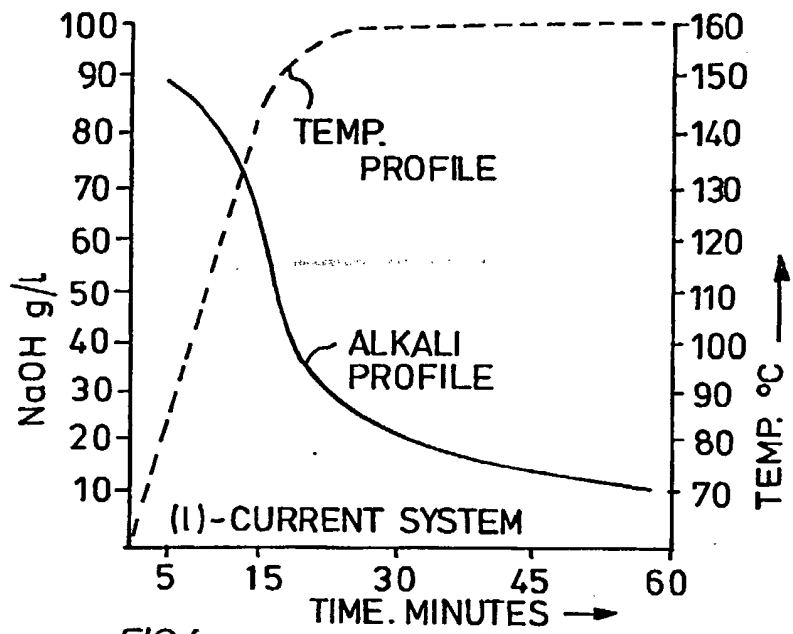


FIG.4

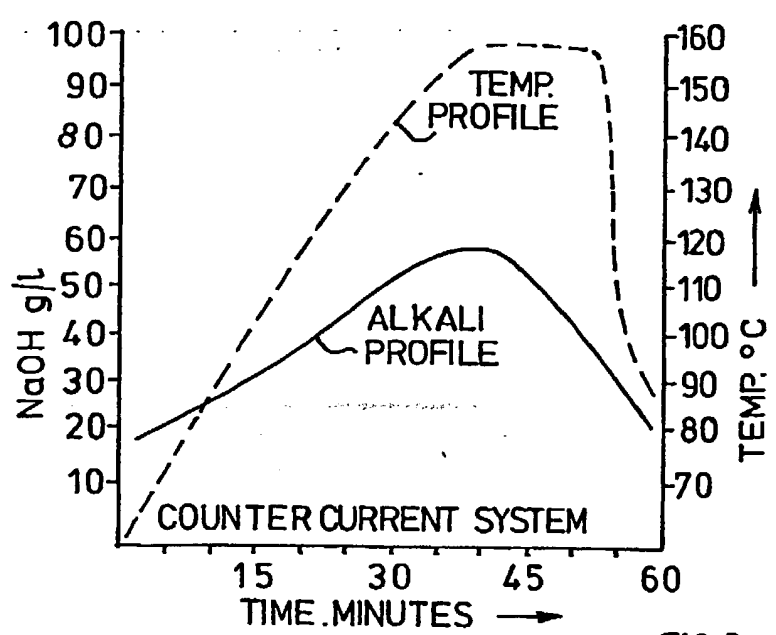


FIG.3

METHOD OF AND APPARATUS FOR PRODUCING CELLULOSIC PAPER PULP

This invention relates to method of and apparatus for producing cellulosic paper pulp. In particular it relates to producing cellulosic pulp from cellulosic materials of low density and relatively low lignin content such as straw and bagasse and portions of annual plants like jute and kenaf.

The draw backs of the traditional system of producing pulp from such raw materials is that they employ "co-current" mode of operation resulting in skewed alkali content, lignin content and temperature profile within the system.

In one known system the raw material from a hopper is fed through a rotary feeder to an impregnation tube where it is treated with alkali and then taken to a digester to get cooked unbleached pulp.

An other known system is based on same as above except that a screw feeder is used and cooking chemicals fed to the feeder before transferring the chemically treated material to the digester.

The result is that when the temperature is high and the actual delignification reaction starts, the alkali concentration of the surrounding liquor is low and lignin and hemicellulose content are high. Consequently there is risk of re-precipitation of lignin and hemicellulose on the fibre.

The present inventions aims at rectifying this skewed alkali profile, reducing the pulping temperature and to monitor the alkali concentration at the right place at right time.

The present invention proposes to achieve the object by making use of a counter-current system.

According to this invention there is provided a process for the manufacture of cellulosic paper pulp from low density raw materials with relatively low lignin content such as straw, bagasse, jute sticks, kenaf and like annual plants comprising feeding the raw material at lower end of a reactor wherein the material is traversed upwards in counter-current to the reacting alkaline liquor fed from the upper end, said alkaline liquor being fed at a temperature of 130 to 160 degree centigrade, treated material being screw pressed and mixed with aqueous magnesium salt such as magnesium sulphate or magnesium carbonate, shredded to open its structure and make it fluffy, treating the so fluffed material with oxygen containing gases in an oxygen reactor at a high temperature, e.g. 95 degree centigrade, mixing the oxygenated material with hot water, e.g. at a temperature of 60-80 degree centigrade to obtain a suspension which is then blown to vent the gases therefrom, and, if and when desired, pressing it to a dryness of 20 to 35 %, e.g. in a screw press.

The present invention also provides an apparatus for manufacture of cellulosic pulp by the method as herein before described comprising an inclined digester with a first port in the region of lower end to feed the raw material, a second port in the region of upper end for feeding reacting alkaline liquor, a third port for discharge of treated raw material, also in the region of upper end of the reactor and an outlet in the region of lower end of the reactor for spent liquor to be discharged therefrom said discharge port leading to a screw press

discharging into a shredder, means to feed aqueous magnesium salt during transfer from the screw press to the shredder, outlet end of the shredder being connected to top of a vertically disposed oxygen reactor, outlet of which reactor is adapted to be connected to conventional washing, screening and bleaching equipment.

In a preferred embodiment the inclined digester is jacketed for insulation against heat losses.

More preferably the inclined reactor is jacketed for circulating steam therethrough to prevent fall of temperature of reacting liquor passed into the reactor.

In one embodiment of the invention the raw material feed port is fitted with a twin drum feeder, which may have an additional rotary valve.

The inclined reactor may have a fourth port in its middle region to recirculate or reintroduce the alkaline liquor squeezed out at the screw press.

The raw material is conveyed up the inclined reactor by a double screw rotating in opposing directions.

The process in general is described below :

The raw material is cut, screened, cleaned and fed at uniform rate to a chute which is kept full. A twin drum feeder controls and feeds the material at uniform rate to a counter-current digester. The digester is a twin screw inclined reactor where the material is carried upwards while the reacting liquor trickles down the reactor through the mass of fibrous raw

material. The speed of twin screws provided in the reactor are adjustable by variable drive located at the top end of the reactor. The reactor is jacketed for heating by steam.

Fresh hot cooking (alkaline) liquor is added at the upper part of the reactor. A part of the fresh liquor is carried forward by the fiber which discharges into a screw press located outside the reactor near upper end.

The pressed fibre still contains some fresh alkali which is sufficient for the oxygen delignification reaction performed after hot alkali (NaCl) extraction performed in the digester.

For operation at temperatures higher than 130 degree centigrade an additional rotary valve is placed after the twin drum feeder to withstand pressure and feed the raw material to the tube.

The twin screws inside the digester have unequal pitch throughout the length of the screws to cause alternate compression and decompression of the mass as it travels upwards. The screws rotate in opposite direction thereby the moving mass is conveyed upward between the two screws. The slope of the reactor is variable, say, between 5 degree to 18 degree. The speed of travel of the raw material mass is variable between 4 m/hr and 10 m/hr.

The semi-cooked pulp, as is discharged from the digester, after the screw press is mixed and shredded by a fast rotating shredder to open the structure and make a fluffy material. The fluffed pulp enters the oxygen reactor from the top. The reactor



is a pressure vessel provided with a number of perforated or slotted plates. A vertical shaft with rotary arms carry the pulp from one part of the plate to the diametrically opposite part before dropping it on to the next plate. The semi-cooked pulp is mixed with a protector which is a Magnesium compound for example  $MgSO$  or  $MgCO$ . The amount of protector varies between 0.1 to 1.2 percent of the weight of pulp. Oxygen gas from a Pressure Swing Absorption (PSA) type O generator is supplied to the reactor at different levels. the gas amount is controlled so that the velocity through perforations fluidise the shredded pulp and cause fast mass transfer. The temperature in the oxygen reactor is maintained at 95 degree centigrade. The oxygenated pulp is then mixed with hot water to form a suspension having 5 - 7% solids and blown to a cyclone which vents the gases. The pulp is thereafter pressed to a dryness of 20 -35% by a screw press. The pulp is now ready for further processing in the traditional manner of screening and bleaching.

The invention is further described below with reference to the accompanying drawings showing in which fig 1 illustrates a conventional co-current process apparatus; fig 2 illustrates a preferred embodiment of the apparatus according to this invention.

Fig 3 and 4 shows graphically temperature and alkali profiles for process of this invention (counter current system) and of known co-current system.

Referring to the drawings, the inclined alkali treatment digester 1 has a twin feeder 2 for feeding the raw material at

inlet port 3 after it is cut, screened and cleaned. The feed rate is kept uniform for proper operation, the control being accomplished by the r.p.m. of the twin feeder 2. Twin screws of unequal pitch as used in the digester 1 are marked 4 and 5 and are driven by external motor(s) 4A & 5A, from upper end of the digester.

Alkaline (cooking liquor) feed port is marked 6 from where the aqueous alkaline liquor flows counter-current to the raw material, while spent liquor flows out at port 7. The liquor is fed at a temperature of 130 degree centigrade and normally a temperature of 130 degree to 160 degree centigrade is maintained in the digester, by means of steam jacket 14. Additional rotary valve 2A is required for operating the equipment at temperatures above 130 degree centigrade.

The digested raw material will run out of port 9 into a screw press 10 to remove most of the reacting liquor still adhering to it from where it travels to a shredder 11 and on the way it is treated with a protector, an aqueous solution of a magnesium salt,  $MgSO_4/MgCO_3$ , at 11A. In the shredder 11 the compressed semi-cooked raw material from screw press is opened up and rendered fluffy.

Material discharging from the shredder 11 is then fed at top 12A of a vertical oxygen reactor 12. The reactor incorporates a plurality of perforated or slotted plates 13 mounted on a rotor 14 so that the material fed at one end of a plate 13 falls from the diametrically opposite end onto the next lower plate 13 while oxygen is fed at various points A, B, C, D, E and F from an oxygen generator 15 which passing through perforations/slots in

plates 13 causes fluidisation' of the material being treated. The oxygen is preferably fed at 95 degree centigrade. The semi-bleached material recovered at the end from the oxygen reactor 12 is mixed with hot water at 19 to a suspension of 5 - 7% solids and blown to a cyclone 17 in a vent 18 from where they may be recycled into the oxygen reactor 12 at 19.

The liquor recovered at the screw press 10 and cyclone 17 may be recirculated from at about the middle region of the reactor at port 8, after being passed through a heat exchanger.

Graph in fig 3 shows that when the temperature is high and the actual delignification reaction starts, the alkali concentration of the surrounding liquor is low and lignin and hemicellulose content are high. Consequently there is risk of re-precipitation of lignin and hemicellulose on the fibre, while from graph in fig 4 it will be seen that alkali concentration is high even at high temperatures while at lower temperatures it is low.

Though the invention is described with reference to an embodiment of this invention it is not limited thereto and its scope is to be determined by the appended claims.

I Claim :

1. A process for the manufacture of cellulosic paper pulp from low density raw materials with relatively low lignin content such as straw, bagasse, jute sticks, kenaf and like annual plants comprising feeding the raw material at lower end of a reactor wherein the material is traversed upwards in counter-current to the reacting alkaline liquor fed from the upper end, said alkaline liquor being fed at a temperature of 130 to 160 degree centigrade, treated material being screw pressed and mixed with aqueous magnesium salt such as magnesium sulphate or magnesium carbonate, shredded to open its structure and make it fluffy, treating the so fluffed material with oxygen containing gases in an oxygen reactor at a high temperature, e.g. 95 degree centigrade, mixing the oxygenated material with hot water, e.g. at a temperature of 60 - 80 degree centigrade to obtain a suspension which is then blown to vent the gases therefrom, and, if and when desired, pressing it to a dryness of 20 to 35 %, e.g. in a screw press.
2. Process as claimed in claim 1 in which the speed of the raw material mass varies between 4 m/hr and 10 m/hr.
3. Process as claimed in claim 1 or 2 in which the suspension made in hot water contains 5 to 7% solids.
4. Process as claimed in any of the claims 1 to 3 in which the alkaline liquor is fed at 130 degree centigrade and temperature in digester maintained between 130 and 160

degree centigrade by means of external heating e.g. by steam.

5. Process as claimed in any of the claims 1 to 4 in which fluffed material in the oxygen reactor is fluidised.
6. Process for the manufacture of cellulosic pulp substantially as hereinbefore described, particularly with reference to the accompanying drawings.
7. Apparatus for the manufacture of cellulosic pulp by the method as hereinbefore claimed comprising an inclined digester with a first port in the region of lower end to feed the raw material, a second port in the region of upper end for feeding reacting alkaline liquor, a third port for discharge of treated raw material, also in the region of upper end of the reactor and an outlet in the region of lower end of the reactor for spent liquor to be discharged therefrom said discharge port leading to a screw press discharging into a shredder, means to feed aqueous magnesium salt during transfer from the screw press to the shredder, outlet end of the shredder being connected to top of a vertically disposed oxygen reactor, outlet of which reactor is adapted to be connected to conventional washing, screening and bleaching equipment.
8. Apparatus claimed in claim 7 in which digester is jacketed against heat loss.
9. Apparatus as claimed in claim 7 in which the digester is jacketed for heating by steam.

10. Apparatus as claimed in any of the claims 7 to 9 in which after the twin drum feeder an additional rotary valve is installed.
11. Apparatus as claimed in any of the foregoing claims 7 to 10 in which the twin screws inside the digester have unequal pitch.
12. Apparatus as claimed in any of the claims 7 to 11 in which the angle at which the digester is inclined is variable, e.g. between 5 and 18 degrees.
13. Apparatus as claimed in any of the claims 7 to 12 in which the oxygen reactor is a vertically disposed -14- chamber with an axial rotor carrying a plurality of perforated or slotted plates and having a plurality of inlets for oxygen opening at a level below each said plate.
14. Apparatus for the manufacture of cellulosic pulp substantially as hereinbefore described particularly with reference to fig 2 of the accompanying drawings.

- 11 -

**Patents Act 1977**  
**Examiner's report to the Comptroller under**  
**Section 17 (The Search Report)**

Application number

GB 9304741.3

**Relevant Technical fields**

(i) UK Cl (Edition L ) D2W (WB,WJ,WK)

(ii) Int Cl (Edition 5 ) D21C

**Databases (see over)**

(i) UK Patent Office

(ii) SELECTED PUBLICATIONS

**Search Examiner**

ALEX LITTLEJOHN

**Date of Search**

7 APRIL 1993

Documents considered relevant following a search in respect of claims 1-14

| Category<br>(see over) | Identity of document and relevant passages  | Relevant to<br>claim(s) |
|------------------------|---|-------------------------|
| A                      | GB 2200928 A (FONGEN) see eg page 5<br>lines 13-25, page 9 lines 5-9<br>and page 21 lines 10-13     |                         |
| A                      | WO 82/01019 A1 (SUNDS) see eg page 2<br>lines 13-24, page 3<br>lines 29-31 and page 4<br>lines 9-25 |                         |
| A                      | US 4338158 (BENTVELZEN) see column 1<br>lines 35-58   |                         |

| Category | Identity of document and relevant passages | Relevant to claim(s) |
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